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Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic)

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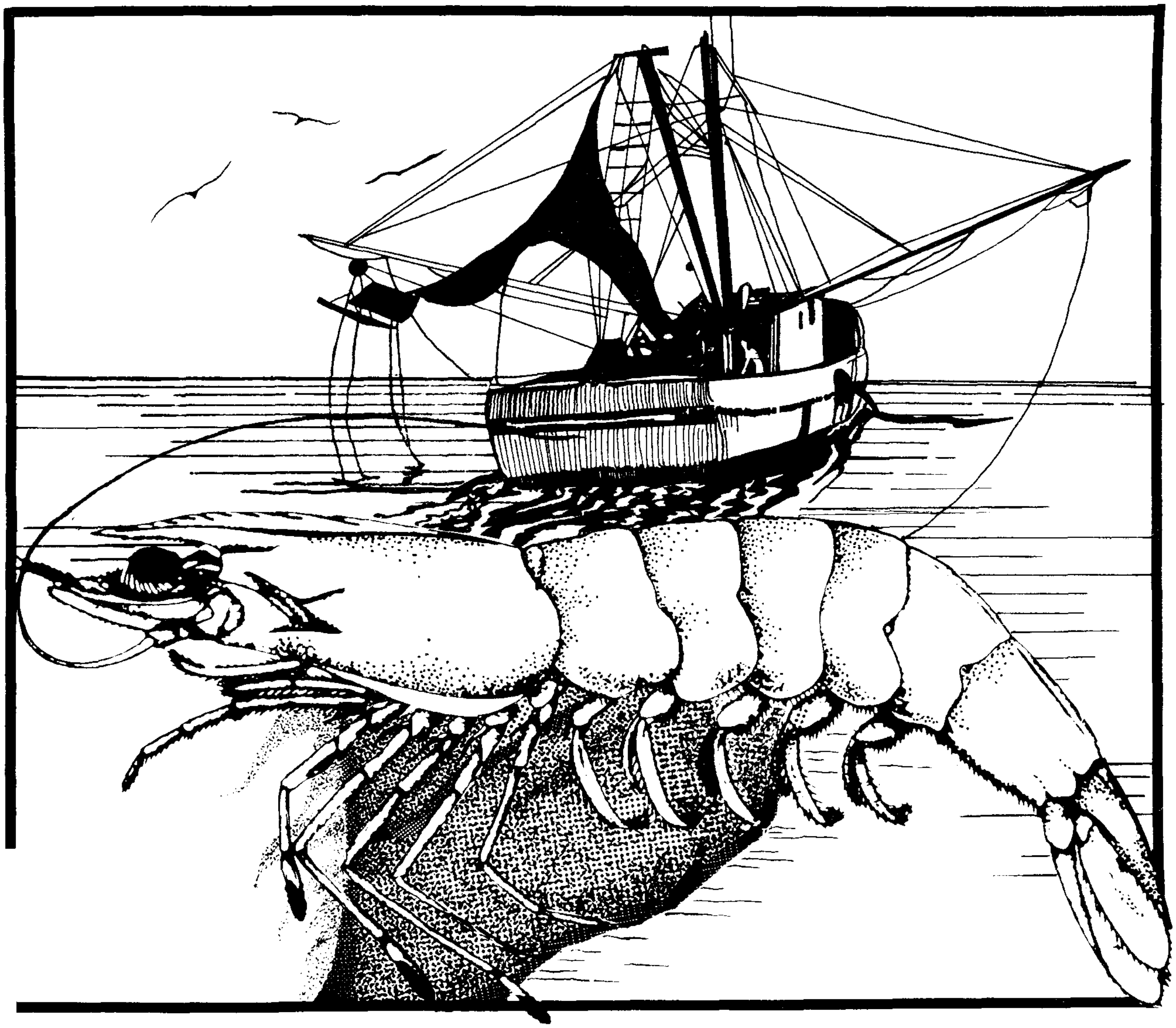

Coastal Ecology Group
Waterways Experiment Station

U.S. Army Corps of Engineers

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Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic)

BROWN SHRIMP

by

Scott C. Larson, Michael J. Van Den Avyle, and
Earl L. Bozeman, Jr.
Georgia Cooperative Fish and Wildlife Research Unit
School of Forest Resources
University of Georgia
Athens, GA 30602

Project Officer
David Moran
U.S. Fish and Wildlife Service
National Wetlands Research Center
1010 Gause Boulevard
Slidell, LA 70458

Performed for

Coastal Ecology Group
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and

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PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

Information Transfer Specialist
National Wetlands Research Center
U.S. Fish and Wildlife Service
NASA-Slidell Computer Complex
1010 Gause Boulevard
Slidell, LA 70458

or

U.S. Army Engineer Waterways Experiment Station
Attention: WESER-C
Post Office Box 631
Vicksburg, MS 39180

Parasites and Diseases

Bacteria isolated from blood of brown shrimp were predominantly *Vibrio*, *Aeromonas*, and *Pseudomonas*. Peritrichous ciliate and suctorian protozoans may be attached to the gills. Gregarine sporozoan protozoans may occur in the digestive tract. Brown shrimp may be infected with larval nematodes and larval cestodes (Fontaine 1985). Diseases and parasites probably do not cause significant direct mortality but may reduce vigor and increase predation rates (Minello and Zimmerman 1989).

ENVIRONMENTAL REQUIREMENTS

Temperature and Salinity

Postlarvae (8-13 mm) have been collected at 13-31 °C. After acclimation at 24 °C, temperatures of 36.6-36.8 °C were lethal. Juveniles have been collected at 2-38 °C; they were stressed at greater than 32 °C and less than 10 °C. Growth was slower below 18 °C. Juveniles may leave estuaries early if large freshwater inflows occur (Zein-Eldin and Renaud 1986). Adverse temperature or salinity levels may not cause direct mortality but may reduce vigor and increase vulnerability to predation (Minello and Zimmerman 1989).

Dissolved Oxygen

Brown shrimp can detect and avoid oxygen-depleted water (Minello and Zimmerman 1989). Juveniles 65-86 mm long avoid 1.5-2 ppm dissolved oxygen (D.O.). Mean lethal D.O. for juveniles of this size was 0.8 ppm after 1.4 ppm/h reduction, and it was 0.5 ppm after 2.6 ppm/h reduction. Adults are unstressed at greater than 4.0 ppm D.O. (Zein-Eldin and Renaud 1986).

System Features

Extended periods of low water will concentrate shrimp and their predators over unvegetated bottom (without cover) and increase predation rates (Minello and Zimmerman 1989).

More information is needed on brown shrimp habitat functions and values (Klima 1989).

REFERENCES

Fontaine, C.T. 1985. A survey of potential disease-causing organisms in bait shrimp from West Galveston Bay, Texas. NOAA Tech. Memo. NMFS-SEFC-169. 25 pp.

Gleason, D.F. 1986. Utilization of salt marsh plants by postlarval brown shrimp: carbon assimilation rates and food preferences. Mar. Ecol. Prog. Ser. 31:151-158.

ADDENDUM--BROWN SHRIMP (SOUTH ATLANTIC). BIOL. REP. 82(11.90).

MORPHOLOGY AND IDENTIFICATION AIDS

Postlarval pink shrimp (Penaeus duorarum) and brown shrimp can be distinguished from postlarval white shrimp (P. setiferus) by spines along the dorsal carina (keel-like ridge) of the sixth abdominal segment which are absent in white shrimp postlarvae (Ringo and Zamora 1968).

LIFE HISTORY

Recent evidence shows that brown shrimp do not die as a result of spawning (Ausbon Brown, National Marine Fisheries Service, Miami, FL; pers. comm.).

ECOLOGICAL ROLE

Feeding

Starvation may be unlikely in estuarine nurseries because food supplies seem adequate. However, reduced food availability may reduce vigor and increase predation rates. Rapid growth permitted by an optimal diet may allow shrimp to grow too large for many predators to eat. In the laboratory, postlarval brown shrimp (about 10-12 mm total length) had positive growth when fed Spartina epiphytes or a species of planktonic diatom. However, growth was slow, and in the field animal foods may be necessary for normal growth. Algae may provide maintenance food when animal food is not available. Detritus derived from Spartina alterniflora did not cause positive growth in postlarvae (Gleason and Zimmerman 1984; Gleason 1986). Juvenile brown shrimp grow faster on vegetated than on nonvegetated bottom. Small benthic animals are more abundant in the vegetated habitat, and the shrimp can feed efficiently on them (Minello and Zimmerman 1989).

Predators

Juvenile brown shrimp may escape fish predation by burrowing into the sediment. In either clear or turbid water, the presence of sand in which to burrow decreased predation by southern flounder but not by Atlantic croaker. The latter fish appears well-adapted to feeding upon burrowed organisms. The effects of clear versus turbid water on predation rates is more complex. Whether sand for burrowing was present or not, turbid water (compared to clear water) increased predation by southern flounder but decreased predation by Atlantic croaker. In clear water, sand reduced predation by pinfish. In turbid water, however, the presence of sand did not reduce predation by pinfish; shrimp burrowed less when the water was not clear (Minello et al. 1987). Predation by fishes may be the major cause of natural mortality to brown shrimp in estuaries (Minello and Zimmerman 1989).

Postlarvae and juveniles prefer vegetated over unvegetated bottom for protection from predators and for food resources (Zein-Eldin and Renaud 1986).

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CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
meters (m)	0.5468	fathoms
kilometers (km)	0.6214	statute miles
kilometers (km)	0.5396	nautical miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters (m^3)	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons (t)	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees (°C)	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

Multiply	By	To Obtain
inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
statute miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
square miles (mi^2)	2.590	square kilometers
acres	0.4047	hectares
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28350.0	milligrams
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
pounds (lb)	0.00045	metric tons
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees (°F)	0.5556 (°F - 32)	Celsius degrees

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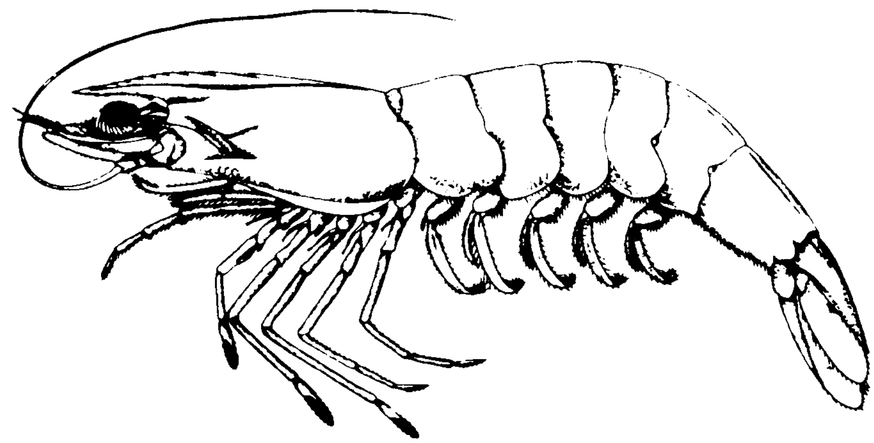

Figure 1. Brown shrimp.

BROWN SHRIMP

NOMENCLATURE/TAXONOMY/RANGE

Scientific name........<u>Penaeus aztecus</u> Ives
Preferred common name.....Brown shrimp (Figure 1)
Other common names......Brownie, green lake shrimp, redtail shrimp, red shrimp, golden shrimp, native shrimp, summer shrimp
Class........................Crustacea
Order.........................Decapoda
Family.......................Penaeidae

Geographic range: Brown shrimp occur from Martha's Vineyard, Massachusetts, to the Florida Keys and then westward and southward in the Gulf of Mexico from Apalachicola Bay, Florida, to the northwest coast of the Yucatan Peninsula. In the South Atlantic Region, brown shrimp are most abundant along the North Carolina coast and are moderately abundant from South Carolina to Florida (Figure 2).

MORPHOLOGY AND IDENTIFICATION AIDS

Detailed descriptions of brown shrimp have been published by Perez-Farfante (1969) and Williams (1984). Brown shrimp may be distinguished from white shrimp (<u>P. setiferus</u>) and pink shrimp (<u>P. duorarum duorarum</u>) by the following features.

Brown shrimp: Adrostral grooves and crests long, extending almost to hind margin of carapace; postrostral crest well developed as far back as adrostral grooves; gastrofrontal crests present; dorso-lateral sulcus on sixth abdominal segment well

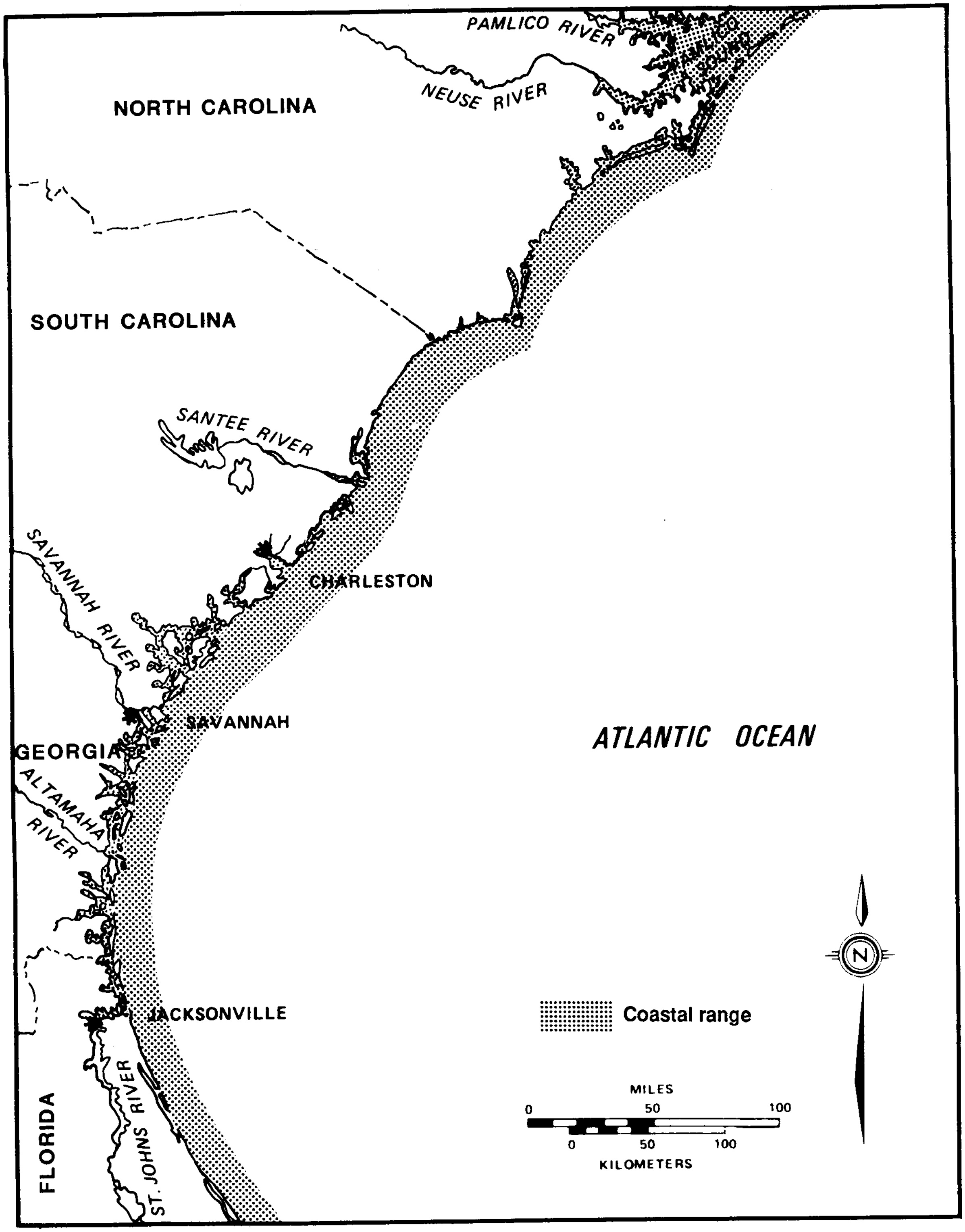

Figure 2. Range of brown shrimp in the South Atlantic Region. Major center of abundance is along the North Carolina coast.

defined and broad; ratio of height of dorsal keel to width of dorso-lateral sulcus usually less than 2.25; dark lateral spot at junction of third and fourth abdominal segments usually absent.

White shrimp: Adrostral grooves and crests short, not exceeding anterior half of the carapace; post-rostral crest scarcely defined posteriorly; gastrofrontal crests absent.

Pink shrimp: Dorso-lateral sulcus on sixth abdominal segment well defined and narrow; ratio of height of dorsal keel to width of dorso-lateral sulcus usually 4.5 or greater, with sharp lips nearly closed; usually a dark spot at junction of third and fourth abdominal segments.

REASON FOR INCLUSION IN SERIES

Brown shrimp account for about one third of the commercial shrimp harvest in the South Atlantic Region. In 1982, the landings were worth $20 million. The species is an important component of estuarine ecosystems, serving as prey for many fish and larger crustaceans. Detritivores such as postlarval and juvenile brown shrimp are essential for converting primary production in estuaries to forms available to higher consumers in the ecosystems.

LIFE HISTORY

Spawning and Larvae

Brown shrimp spawn offshore at depths usually exceeding 18 m (Pearson 1939; Gunter 1956; St. Amant et al. 1965; Christmas et al. 1966; Baxter and Renfro 1967; Temple and Fischer 1967; Perez-Farfante 1969; Anderson 1970; Shipman et al. 1983). Spawning occurs in the South Atlantic Region from North Carolina to northeast Florida (Perez-Farfante 1969; Anderson 1970) during most of the year. Shipman et al. (1983) suggested that the major spawning period may extend into early fall in the southern portion of the South Atlantic Region. Subrahmanyam (1971) reported that brown shrimp spawn in the Gulf of Mexico in spring and summer when bottom water temperatures are between 17 and 29 °C, and cease spawning when water temperatures begin to decline in fall. Adults apparently die after spawning once (St. Amant et al. 1966).

Eggs are demersal, nonadhesive, spherical, and 0.26-0.28 mm in diameter (Pearson 1939; Temple and Fischer 1967; Perez-Farfante 1969). Hatching usually occurs within 24 hours, but is inhibited at salinities below 27 parts per thousand (ppt) or above 35 ppt (Cook and Murphy 1969). Planktonic larvae develop offshore through five naupliar, three protozoeal, and three mysis stages before metamorphosis to postlarvae (Pearson 1939; Baxter and Renfro 1967; Kutkuhn 1966; Temple and Fischer 1967). Larval development takes about 11 days at 32 °C or 17 days at 24 °C, and development stops at temperatures below 24 °C (Cook and Murphy 1969).

Postlarvae

Surface ocean currents transport postlarvae to coastal areas during late winter and spring (Whitaker 1981a). Bearden (1961) collected large postlarvae off South Carolina during late winter and early spring, suggesting that postlarvae overwinter in offshore waters in the South Atlantic Region. Postlarvae begin to move from coastal areas into estuaries when water temperatures rise above 11 °C (St. Amant et al. 1965; Christmas et al. 1966; Williams and Deubler 1968). They immigrate to nursery areas in March through June in North Carolina, March and April in South Carolina, and March to June in Georgia and Florida. Some may immigrate during fall in Georgia and northeast Florida (Williams 1964, 1965; Shipman et al. 1983). Postlarvae are transported into estuaries by incoming tides. Williams (1964) reported that more postlarvae entered North Carolina sounds at night than during the day, and during a new moon than during a full moon. Postlarvae inhabit shallow, low-salinity areas in marsh-grass communities (Gunter 1956; St. Amant et al. 1965; Williams 1965; Kutkuhn 1966). Growth and metamorphosis to the juvenile stage is rapid due to the abundance of food available in this habitat (St. Amant et al. 1965).

Juveniles and Adults

Juvenile brown shrimp occupy estuarine nursery grounds in the South Atlantic Region from March through July, moving to larger bays as they grow. They eventually emigrate to deeper, more saline waters to mature (Williams 1965). St. Amant et al. (1965) indicated that increased temperature or crowding may initiate the offshore movement. Reductions in salinity cause migration in North Carolina. Jackson (1974) observed juvenile brown shrimp emigrating from Cedar Bayou, Texas, when they were 100-120 mm in total length (TL).

Female brown shrimp reach sexual maturity at about 140 mm TL (Renfro 1964; Cook and Lindner 1970). Burkenroad (1939) reported that female brown shrimp attain gonadal ripeness at about 145 mm TL. Anderson (1970) collected gravid females of 143-153 mm TL from South Carolina to northeast Florida during fall.

Seasonal movements of adult brown shrimp are apparently related to water temperature patterns (Zein-Eldin and Aldrich 1965). Distribution patterns during the winter are poorly understood (McCoy 1972; Shipman 1980; Shipman et al. 1983). White shrimp from the Carolinas and Georgia overwinter off the northeast coast of Florida, and Anderson (1970) suggested that brown shrimp might do likewise. There is no conclusive evidence, however, that the Florida coast is an overwintering area for adult brown shrimp.

GROWTH

Growth rates of brown shrimp may vary considerably due to differences in water temperature, salinity, and food availability. Nearly all published brown shrimp growth data relate to postlarvae and juveniles because of their availability for study and because such data are useful for predicting commercial harvests.

Daily growth rates of postlarvae and juveniles determined from field studies ranged from 0.52 to 1.67 mm, and averaged 1.0-1.5 mm during the major growth period in late spring and early summer (Williams 1955; St. Amant et al. 1966; McCoy 1968; Knudsen et al. 1977). Average daily growth (total length) of juveniles reared in ponds receiving heated water from an electric power plant was 1.1-1.5 mm in spring, and 1.0-1.4 mm in summer (Gould 1973). Zein-Eldin and Griffeth (1966) indicated that postlarval growth rates increased when temperatures exceeded 15 °C. St. Amant et al. (1965) observed that growth from the postlarval to the juvenile stage took less than 4 weeks in estuarine waters of temperatures above 20 °C; when postlarvae moved into water at temperatures lower than 20 °C, however, growth was delayed, mortality was high, and the subsequent commercial harvest was low. St. Amant et al. (1965) reported daily juvenile growth rates of 0.1, 1.0, and 1.5 mm at temperatures of 16, 20, and 25 °C, respectively. Venkataramaiah et al. (1972) found that growth and food conversion were highest at 26 °C.

Sexual differentiation in brown shrimp typically begins at about 50 mm TL (Fontaine and Neal 1971). Growth slows markedly as shrimp reach 100 mm TL (Gould 1973), beyond which males usually grow slower than females (Williams 1955). In the Gulf of Mexico, male brown shrimp reach about 60% of the weight and 83% of the length of females (Parrack 1979). McCoy (1968, 1972) provided brown shrimp growth estimates for the New River Inlet and Pamlico Sound, North Carolina (Table 1). The New River Inlet estimates predicted more rapid growth and larger maximum size for females. The Pamlico Sound growth estimate was for combined sexes, with a theoretical maximum of 178 mm TL. Relationships between wet weight and total length, weight and carapace length, and total length and carapace length, developed by McCoy (1972) and Fontaine and Neal (1971), are shown in Table 2.

THE FISHERY

McKenzie (1981) and Shipman et al. (1983) provided descriptions of fishing methods, catch statistics, management objectives, and social,

Table 2. Relationships between wet weight (g), total length (mm), and carapace length (mm) for brown shrimp.

Weight (W) versus total length (TL)[a]	
Males	$W = 11.61 \times 10^{-6} TL^{2.91}$
Females	$W = 9.53 \times 10^{-6} TL^{2.94}$
Combined	$W = 10.52 \times 10^{-6} TL^{2.94}$
Weight versus carapace length (CL)[b]	
Males	$W = 8.2 \times 10^{-4} CL^{2.94}$
Females	$W = 11.3 \times 10^{-4} CL^{2.84}$
Total length versus carapace length[b]	
Males	$TL = 3.50 + 4.16\ CL$
Females	$TL = 10.50 + 3.83\ CL$

[a]Data from Texas (Fontaine and Neal 1971).
[b]Data from North Carolina (McCoy 1972).

Table 1. Equations for predicting total length (TL) in millimeters from age (t--in weeks) for brown shrimp in North Carolina.

	Equation[a]	Location	Source
Males	$TL_t = 128(1-e^{-0.317[t+5.98]})$	New River inlet	McCoy (1972)
Females	$TL_t = 151(1-e^{-0.171[t+7.20]})$	New River inlet	McCoy (1972)
Sexes combined	$TL_t = 178(1-e^{-0.073t})$	Pamlico Sound	McCoy (1968)

[a]The number to the immediate right of the equal sign is an estimate of the maximum total length attained.

economic, and political aspects of the South Atlantic Region shrimp fishery. Most information in this section is taken from their reports.

The penaeid shrimp fishery is the most valuable commercial fishery in North America. United States penaeid shrimp landings in 1982 had an exvessel value of more than $590 million. About 10% of the landings were from the South Atlantic Region (National Marine Fisheries Service [NMFS] 1983). Annual penaeid shrimp landings from 1970 to 1979 in the South Atlantic Region averaged about 15.5 million lb (7,030 metric tons) (heads-off); brown shrimp composed about 35% (McKenzie 1981). The values of recreational and bait shrimp fisheries throughout the region are unknown.

In the South Atlantic Region, commercially important brown shrimp fishing grounds extend from Fort Pierce, Florida, to Pamlico Sound and Ocracoke Inlet, North Carolina. Most of the commercial harvest is taken inside the 10-fathom contour. This shallow area is widest along north and central Georgia, and narrowest along Florida and North Carolina. Trawling deeper than 10 fathoms may be limited in some areas by rough bottoms and sparsity of shrimp.

The brown shrimp harvest peaks in July and August and continues into late fall in North Carolina, extends from mid-June to early fall in most of South Carolina, is primarily in July and August in Georgia, and extends from the opening of the night trawling season (June 1) through late August in Florida.

The shrimp fishery in the South Atlantic Region is regulated by local and Federal laws that are based on biological, economical, and sociopolitical concerns. The South Atlantic Fishery Management Council has assumed responsibility for a shrimp management plan for the Federal Conservation Zone, but the plan is still in the preliminary stage. Most shrimp fishery management actions are intended to protect undersized (precommercial) shrimp or overwintering stocks in order to maximize economic yield. These actions include establishing closed seasons, prohibiting commercial fishing in certain estuaries, and limiting the size of shrimp that can be harvested. Management efforts have been hampered by the lack of accurate data on natural mortality, fishing mortality, and other population parameters of shrimp stocks. Management approaches, economic concerns, and further data needs for effective management were discussed in McKenzie (1981), Purvis et al. (1976), and Shipman et al. (1983).

ECOLOGICAL ROLE

Brown shrimp are omnivorous and eat food items ranging from detritus to small invertebrates and fish during their life cycle (Hunt et al. 1980). Williams (1955), who examined the stomach contents of juvenile and adult brown shrimp from North Carolina, found that the most abundant material was an unrecognizable mixture of partly digested organic matter and bottom debris. He also found chitin fragments, setae and jaws from annelid worms, foraminiferans, minute gastropod and lamellibranch shells, squid suckers, small fishes, muscle fibers, gut fragments, mandibles, ribs, eye lenses, unidentifiable eggs, and plant fragments and seed-pods. Jones (1973) found a shift in the diet and habitat of juvenile brown shrimp in Louisiana as they increased in size. The smallest shrimp examined (24-44 mm TL) fed nonselectively on the top sediment layer; shrimp 45-64 mm TL selected the organic fraction of the top sediment layer, and shrimp 65-104 mm TL were active predators that ate polychaetes, amphipods, nematodes, and chironomid larvae.

A host of predators, including carnivorous fishes and crustaceans, feed on brown shrimp, but the role of predation in regulating shrimp populations is unknown (Gunter 1945; Darnell 1958; Hunt et al. 1980). Competition between brown shrimp and the two other commercially important penaeid species (pink and white shrimp) is probably minor due to differences in substrate and salinity preferences and temporal differences in the use of estuaries (Williams 1958; Gunter 1961). Other species, however, may compete with brown shrimp for food. Gould (1973) reported competition for food between brown shrimp and small fish in a culture pond.

ENVIRONMENTAL REQUIREMENTS

Temperature and Salinity

Adverse temperatures or salinities reduce brown shrimp survival (Copeland and Bechtel 1974). Under laboratory conditions, larvae did not complete development at temperatures below 24 °C (Cook and Murphy 1969). The survival rate of brown shrimp nauplii was higher at 24 °C than at 20, 28, or 32 °C, and both protozoeal and mysis survival rates increased with temperature from 24 to 32 °C. Survival rates of postlarvae increased with temperature from 15 to 20 °C, remained above 90% from 20 to 25 °C, and decreased at temperatures greater than 25 °C (Zein-Eldin and Griffeth 1966). At salinities below 27 ppt or above 35 ppt, hatching was inhibited and survival of larvae decreased (Cook and Murphy 1969).

Brown shrimp burrow in response to low temperatures. Shrimp in aquaria burrowed at temperatures of 12-17 °C and emerged at temperatures of 18-21.5 °C (Venkatamariah et al. 1972). Aldrich et al. (1968) reported that adults offshore burrowed during winter, and juveniles in estuaries burrowed during cold-weather periods in the spring. Burrowing may serve to moderate temperature extremes and act as a predator avoidance mechanism.

Venkatamariah et al. (1972) observed convulsions and disoriented movements of brown shrimp at salinities less than 2 ppt. Brown shrimp have been collected, however, at salinities as low as 0.2 ppt in Alabama estuaries (Swingle 1971). Zein-Eldin (1963) found that survival rates of postlarvae were high at salinites of 2-40 ppt under conditions of restricted diet, and Williams (1960) reported that brown shrimp could maintain their ionic balance at salinities up to 69 ppt, indicating that they can survive salinities higher than those tested by Zein-Eldin (1963).

Although brown shrimp can tolerate wide ranges of salinity and temperature, interactive effects occur when one or both of these factors are unfavorable. Venkatamariah et al. (1972) reported that brown shrimp survived temperature changes best at salinities of 8.5-17 ppt, and tolerated the widest range of salinity at 26 °C. The salinity tolerance of brown shrimp was reduced at temperatures below 20 °C (Copeland and Bechtel 1974), and tolerance to salinities below 10 ppt was markedly reduced at temperatures below 15 °C (Zein-Eldin and Aldrich 1965).

Landings records support these laboratory findings. Hunt et al. (1980) found that commercial brown shrimp harvests were low after periods of low temperature and salinity in Pamlico Sound, North Carolina, and high after periods of high salinity and temperature. St. Amant et al. (1965) reported that commercial brown shrimp production in Louisiana was low when postlarvae recruited early to areas of low salinity (less than 8 ppt) and temperature (less than 20 °C), but was higher when shrimp recruited at later dates to areas with temperatures greater than 20 °C and salinities greater than 15 ppt.

Substrate and System Features

Adult and juvenile brown shrimp have been collected over muddy or peaty substrates by researchers and fishermen (Perez-Farfante 1969; Hunt et al. 1980). Williams (1958), who tested the preference of brown shrimp for different substrate types (including sand, shell-sand mixtures, silt, loose peat, muddy sand, and sandy mud) found that they prefer loose peat and sandy mud, although they frequent other substrates such as sand, silt, or clay mixed with rock fragments.

Availability of cover is an essential requirement for brown shrimp nursery areas (Williams 1955; Kutkuhn 1966). Turner (1977) reported that the abundance and type of commercially important penaeids is directly related to the amount of intertidal vegetation available for nursery habitats. The size of shrimp reaching commercial fishing grounds may be density dependent, and in years of high recruitment, there may not be enough nursery habitat for maximum production (McKenzie 1981).

Bulkheading, ditching, disposal of dredged material, and drainage from agricultural or silvicultural areas may reduce the suitability of some estuaries as nursery areas (Kutkuhn 1966; Jones and Sholar 1981; McKenzie 1981). Bulkheading reduces the marsh-water interface that is critical habitat to postlarval and juvenile stages of brown shrimp. Excessive surface drainage into estuaries can affect salinity patterns, and contribute substantial amounts of pesticides and sediment to the ecosystem. Ditches and canals can also affect salinity patterns in estuaries and prevent the influx of shrimp (Jones and Sholar 1981). The disposal of dredged material covers nutritive substrates used by shrimp and may result in gill erosion and egg suffocation (Whitaker 1981b). Existing estuarine areas must be preserved to ensure the continued commercial production of brown shrimp.

Other Environmental Requirements

Other factors regulating the occurrence and development of brown shrimp are water circulation and turbidity. Currents generated by wind and tide govern the distribution of chemical components, temperature, suspended matter, and planktonic organisms in the water column. Although turbidity has not been conclusively linked with shrimp distribution, aerial photographs have shown a positive relation between turbid areas and concentrations of shrimp in the Gulf of Mexico (Lindner and Bailey 1969). Turbidity may reflect the nutritive potential of the water, and serve to protect shrimp from predation (Kutkuhn 1966).

Few field studies have been conducted that relate the occurrence of brown shrimp to dissolved oxygen concentration. Trent et al. (1976) noted a decrease in brown shrimp abundance at altered marsh sites in Texas, where dissolved oxygen concentrations were below 3.0 mg/l. Bishop et al. (1980) reported that oxygen consumption rates of brown shrimp increased significantly with temperatures from 18 to 33 °C, but that differences in oxygen consumption rates at test salinities of 10 ppt, 20 ppt, and 30 ppt were negligible. At 20 ppt 3.7-g brown shrimp used significantly more oxygen per gram than did 6.7-g brown shrimp; there was no significant difference between sizes at 10 ppt and 30 ppt.

Sindermann and Rosenfield (1968) and Couch (1979) reviewed the major parasites and diseases affecting brown shrimp. Microsporidian protozoans, which destroy muscle tissue and gonads, may be the most important brown shrimp parasite.

The effects of several environmental pollutants and pesticides on brown shrimp were reported by Couch (1979) and Whitaker (1981b). Malathion, toxaphene, methyl parathion, and DDT are among the pesticides detrimental to brown shrimp.

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16. Abstract (Limit: 200 words)

Species profiles are literature summaries of the life history, distribution, and environmental requirements of coastal fishes and invertebrates. Profiles are prepared to assist with environmental impact assessment. Brown shrimp (Penaeus aztecus) account for about one-third of the commercial shrimp harvest in the South Atlantic Region; the landings were worth $20 million in 1982. In the South Atlantic Region, commercially important brown shrimp fishing grounds extend from Fort Pierce, Florida, to Pamlico Sound and Ocracoke Inlet, North Carolina. Most of the commercial harvest is taken inside the 10-fathom contour. Brown shrimp are omnivorous and eat food items ranging from detritus to small invertebrates and fishes. Many predators, including fishes and crustaceans, feed on brown shrimp. Brown shrimp survival is reduced by adverse temperature or salinities. Intertidal vegetation is an important characteristic of brown shrimp nursery areas. The suitability of some estuaries as nursery areas may be reduced by bulkheading, ditching, disposal of dredged materials, and drainage from agricultural and silvicultural areas. Existing estuarine areas must be preserved to ensure the continued production of brown shrimp.

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Temperature requirements
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1010 Gause Boulevard
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